Preservice Elementary Teachers' Analysis of Mathematics Instructional Materials

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ABSTRACT: This article explores the practice of engaging prospective elementary teachers in the analysis of lessons from different textbooks. A rationale for such engagement, based on particular teacher education goals, is provided. The article focuses on a specific lesson analysis assignment given to prospective elementary teachers in which portions of mathematics textbooks were compared and contrasted. Examination of 23 preservice teachers' analysis of two textbook lessons (one fairly traditional and one more reform oriented) revealed that, with very few exceptions, the preservice teachers searched the textbook lessons for familiar, mainly traditional instructional components. The teachers' preference for traditional lesson components appeared to contribute to a tendency to make considerable misinterpretations of the two textbook lessons. These tendencies, including ways that the teachers attempted to justify differences between the two lessons, offer important insights into prospective elementary teachers' conceptions of the role of textbooks in the teaching and learning process. In addition, these findings suggest the necessity of involving prospective teachers more extensively in the analysis of textbooks, curriculum materials, and other instruction resources so that richer, more useful conceptions may develop.

In most subject areas of the school curriculum, new standards and guidelines have been published over the past decade (e.g., National Council for the Social Studies, 1994; National Council of Teachers of English and the International Reading Association, 1996; National Council of Teachers of Mathematics [NCTM], 1989, 2000; National Research Council, National Committee on Science Education Standards and Assessment, 1996). In response to these new curriculum standards, many innovative instructional materials have been published with the explicit intent of helping teachers and students enact reform-oriented subject matter and pedagogical goals. These standards-based instructional materials not only incorporate novel approaches to content, but also invite teachers and students to participate in more student-centered classroom activities.

Although the current climate of reform in U.S. schools offers exciting new opportunities for those preparing to enter the teaching profession, reform also poses significant *challenges* to prospective teachers, many of whom have never experienced learning or teaching in reform-oriented ways (or with standards-based instructional materials). As teacher educators, we are concerned with preparing these preservice teachers to not only embrace the curriculum standards and theories that we hope will guide

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their future pedagogical decision making but also to effectively utilize the sorts of instructional resources that will be available to them.

This article explores issues emerging from a teacher education activity in which preservice elementary teachers were invited to analyze selected sections of different mathematics instructional materials (i.e., traditional textbooks and reform-oriented curriculum materials).[1] Although this activity took place in a mathematics class for preservice teachers and involved the exploration of mathematics instructional materials, the outcomes have implications for teacher educators in many other academic areas.

Rationale

The notion that activities related to instructional materials can lead to significant learning by preservice teachers is not new. Recent research has documented ways in which inservice teachers may be compelled to develop new subject-matter understandings and new pedagogical practices as they teach with reform-oriented curriculum materials (Ball & Cohen, 1996; Lloyd, 2002a; Remillard, 2000; Russell et al., 1995). Researchers have also documented teachers' learning during participation in Chinese and Japanese models of textbook analysis and lesson study (Ma, 1999; Stigler & Hiebert, 1999; Watanabe, 2002). Although preservice teachers lack the opportunity and experience needed to participate in curriculum implementation or lesson study, most teacher education programs require preservice teachers to develop, teach from, and reflect on lesson plans. Some teacher educators also offer preservice teachers direct experience with innovative curricular designs by using reform-oriented K–12 curriculum materials as the basis for subject-matter learning (Lloyd, 2002b, 2004; Lloyd & Frykholm, 2000). These ways of using lesson plans and instructional resources in teacher education appear to offer fruitful strategies for helping preservice teachers to learn about both pedagogy and subject matter.

This article proposes the guided analysis of instructional materials as another effective teacher education activity. We suggest three possible reasons that the analysis of instructional materials may be a uniquely valuable activity in which to engage preservice teachers. First, teachers may benefit from exposure to reform-oriented curriculum materials so that they can become more familiar with new representations of content and new recommendations for classroom activities. Comparisons between various instructional materials may offer preservice teachers opportunities to reach informed decisions about the relative educational value of different curricular designs. By considering the diverse learning theories on which different instructional materials are based, preservice teachers may be able to improve their ability to predict what types of understandings their students would gain through the use of these materials. Because preservice teachers will one day leave the university to become key curriculum decision makers in their own classrooms and schools, development of the ability to weigh the advantages and disadvantages of different instructional materials is critically important.

Analysis of instructional materials also requires teachers to consider subject matter and pedagogy together, in relation to one another. Traditionally, the course work component of teacher preparation has maintained a separation between content (subject matter) and pedagogy. More recent trends have included recognition of the value of integrating content and pedagogy within teacher education courses and programs (Ball & Bass, 2000; Cochran & Jones, 1998; Edwards, 1997; McArthur, 2004; Thornton, 2001; Wilson, 1994; Yager & Penick, 1990). Because, in the analysis of instructional materials, preservice teachers are asked to consider materials from the perspectives of learners *and* future teachers, they must utilize both subject-matter knowledge and pedagogical conceptions. Doing so may help preservice teachers to begin to develop the *pedagogical content knowledge* (Shulman, 1987) they will need for their future teaching.

Finally, as most teacher educators are aware, it is often difficult to establish a context in which preservice teachers are able to access

and reveal their often tacitly held beliefs about teaching (Cooney, 1985; Fenstermacher, 1979). The problems and activities contained within instructional materials can provide very specific topics for discussion and analysis. For example, analysis may include exploration of why one set of instructional materials *begins* by providing a formula, but another *ends* with student development of that same formula to solve a real-world problem. This sort of comparison may compel teachers to explore some of their own unquestioned beliefs about the learning of mathematics.

Context for Preservice Teachers' Analysis of Instructional Materials

The Preservice Teachers and the Course

Participants in this study were 23 preservice elementary teachers in an undergraduate mathematics course titled Geometry and Computing for Teachers. The course met once weekly for 3 hours and took place during the spring semester of the 2002–2003 academic year at a large state university located in the Mid-Atlantic region of the United States. Students in the class were preservice elementary teachers, all female, in either their 2nd or 3rd years of a 5-year elementary education program. The instructors of the course, a mathematics education professor and a mathematics education doctoral student, designed the analysis assignment and are also the authors of this report.

This mathematics course focused on a variety of two- and three-dimensional geometry and measurement topics. As part of a larger ongoing research project related to teacher learning with K–12 curriculum materials, selected units from reform-oriented middle school curriculum materials were being used as the primary mathematical texts in the course. With the exception of the assignment described in this report, all course activities focused the preservice teachers on using curriculum materials as learners of mathematics. The particular units, chosen from the reform-oriented *Mathematics in Context* and *Connected Mathematics Project* curriculum materials, were selected to correspond to the mathematical emphases typically found in a geometry course for preservice elementary teachers.

The Assignment: Teachers' Analysis of Instructional Materials

Although the teachers worked extensively with the curriculum materials to learn mathematics in the course, we were also interested in gaining information about how the teachers might be thinking about *pedagogical* issues related to the reform-oriented curriculum materials. With the dual purpose of attaining this information and offering teachers a chance to reflect on and articulate their views of curriculum and teaching, we designed an activity focused on the analysis of mathematics instructional materials.

During the fifth week of a 15-week semester, the preservice teachers were given copies of selected student pages from two different sets of instructional materials. (These instructional materials are described in the next section of this report.) For this assignment, due at the end of the 8th week of the semester, the preservice teachers were asked to first give an open-ended analysis of each set of instructional materials. This part of the assignment was intentionally kept unstructured to offer the preservice teachers a chance to develop their own ideas about what to look for when examining instructional materials. The second part of the assignment was more specific, asking the preservice teachers to respond to 10 questions focusing on the comparison of the two sets of instructional materials. They were asked to analyze the differences between the two sets of instructional materials, describe what they liked more or less about each one, explain which they preferred for students or teachers, indicate any changes they might make, suggest what they thought were the main ideas and mathematical understandings that students would gain, and then choose which set they would prefer to use in their future classrooms. The assignment sheet is included in the Appendix of this article.

The Instructional Materials

Selection of the instructional materials that we asked the teachers to analyze was very deliberate. We aimed to find two fairly self-contained sets of instructional materials that dealt with the same mathematical topic but in different ways. Specifically, we wished to find materials that incorporated distinctly different assumptions about teaching and learning. Our search for two such sets of instructional materials was guided, in part, by distinctions between reform-oriented and more traditional mathematics instruction drawn by Simon (1994) and outlined in Table 1. Although Simon's distinctions offer extreme characterizations of the assumptions on which instruction might be based, the distinctions served to structure our decision making about the qualities of instructional materials that might be productive for teachers to consider. In particular, we sought two sets of instructional materials containing distinctly different opportunities for students to communicate about mathematics, participate in genuine problem solving and generalization about mathematical ideas, develop and test their own ideas and hypotheses, foster their own sense of mathematical authority, and connect their learning to new ideas and questions.

With these distinctions in mind, the sets of instructional materials selected for the teachers to analyze are as follows:

- Set A: "Measuring Parallelograms" and "Measuring Triangles" from the unit *Covering and Surrounding* (Lappan, Fey, Fitzgerald, Friel, & Phillips, 1998, pp. 46–59) of the Connected Mathematics Project [CMP], and
- Set B: "Area of Polygons" from the textbook, *Mathematical Connections: A Bridge to Algebra and Geometry* (Gardella, Frase, Meldon, Weingarden, & Campbell, 1992, pp. 445–449).

Both sets of instructional materials focused on finding areas of rectangles, parallelograms, and triangles. However, they differed greatly in length, presentation, and overall design. Each set of materials is described below.

Set A begins with a brief review of finding the area of rectangles by counting square units, reminding students that although the goal of the activity is to find shortcuts for finding the area of special figures, they could cover a figure with grid squares and count squares to find the area. It then asks students to find, in whatever way they could, the area of several rectangles and parallelograms and explain their methods. Several more problem statements follow, asking students to create various parallelograms that meet certain constraints. The following task is then posed:

> Summarize what you have discovered from making parallelograms that fit given

Table 1. Distinctions Between Reform-Oriented and Traditional Mathematics Instruction

Reform-Based Instruction	*Traditional Instruction*
1. Situations for students to communicate mathematical ideas and engage in negotiation of meaning	1. No situations for students to communicate mathematical ideas and engage in negotiation of meaning
2. Problem solving in a specific context followed by abstraction/generalization of ideas	2. Presentation of an abstract idea followed by application in specific contexts
3. The concepts discussed are developed by students and expressed in their language	3. The concepts discussed are presented by the teacher in his/her own language—the language of the communities in which he/she belongs
4. The responsibility for determining the validity of ideas resides with the classroom community	4. The responsibility for determining the validity of ideas resides with the teacher or is ascribed to the textbook
5. Application is the exploration of new ideas or extensions of ideas previously developed	5. Application is limited to the practice and use of the general idea presented

> constraints. Include your feelings about what kinds of constraints make designing a parallelogram easy and what kinds of constraints make designing a parallelogram difficult. Have you discovered any shortcuts for finding areas of parallelograms? If so, describe them. (Lappan et al., 1998, p. 49)

Set A goes on to state that, as students have probably discovered in their work, it would be useful to develop an easy way to find area without having to count grid squares. It instructs students to draw and cut out several nonrectangular parallelograms, cut each into two pieces, and try to reassemble them to form rectangles. They record the base, height, perimeter, and area of the original parallelograms and the newly formed rectangles and the following question is posed: "What relationships do you see between the measures for the rectangle and the measures for the parallelogram from which it was made?" (p. 50). Students are then asked to use what they have learned to find the area and perimeter of a given parallelogram. It continues, using the same questioning and exploration approach, this time focusing on what students have learned about parallelograms to find a shortcut for finding the area of triangles.

Set B begins by explaining to students how to find the area of a rectangle by counting grid squares. The students are asked to think about a simpler way to find the area of a rectangle and are then shown a list of formulas and diagrams (for finding the area of squares and rectangles) and an example calculation. The materials illustrate how any parallelogram can be "rearranged" into a rectangle, noting the similarities between the area formulas for rectangles and parallelograms. The formula for finding the area of a parallelogram and an example follows. Next appears an explanation of how to find the area of a triangle by thinking of it as one half of the area of a parallelogram, followed by the formula for finding the area of a triangle and one last example. Set B concludes with a variety of practice problems, some asking students to find the areas of given figures, some fill-in-the-blank questions focused on comparing the areas of various rectangles, parallelograms, and triangles, and some career/application problems. Sample questions follow:

- Make a sketch of a parallelogram with base 8.5 in. and height 6 in. (Gardella et al., 1992, p. 447)
- Find the height of a triangle with area 36 ft^2 and base 8 ft. (p. 447)
- Group Activity: Using a newspaper, find the cost of several types of flooring. Which type is most expensive? Least expensive? Calculate the cost of installing three types of flooring in your classroom. What factors should you consider when choosing a flooring? (p. 449)

These sorts of problems comprise the conclusion of Set B.

The Authors' Bias

Because most claims about instructional materials are reflective of some professional or personal perspective, it is important for the reader to be aware of our bias. Although reform-oriented curriculum materials can be used as the basis for traditional classroom instruction (and vice versa), it is our bias that Instructional Set A is considerably more likely to form the basis for reform-oriented instruction (of the type outlined in Table 1) than is Instructional Set B. As illustrated in the description above, Set A explicitly attempts to have students develop, test, and communicate their own ideas about ways to find the areas of parallelograms and triangles. In contrast, Set B offers very few opportunities for students to develop or communicate about mathematical ideas—instead, the materials outline all the information that students need to know.

As teacher educators and researchers, we were interested in how the preservice teachers might react to distinctions between these two sets of instructional materials. We recognize that our bias toward reform-oriented curriculum materials may have been shared with

teachers because, in our mathematics course, we implemented other materials from the same reform-oriented curriculum series (*Connected Mathematics*) from which Set A was extracted. However, we intentionally never initiated or participated in any explicit conversations about different instructional materials with the preservice teachers. This decision was necessary for the larger research study of which the present report is part.

Interpreting the Teachers' Written Reports

Data for this article consist of the 23 preservice teachers' written responses to the assignment appearing in the Appendix. To synthesize and interpret the teachers' written analyses of the two sets of instructional materials, we started by reading the entire collection of papers two times. During the first review, we had two goals in mind: to get an initial sense of the types of responses and to create a summary of each paper. The second review was intended to further develop the common ideas that seemed to be surfacing, as well as to improve the information that was recorded during the first review. In particular, our reviews aimed to identify the criterion the teachers seemed to be using for reading and evaluating the instructional materials, as well as those factors that seemed to be primary in their ultimate decisions about which set of instructional materials they preferred. For instance, as elaborated in the next section of the report, many students looked at the instructional materials in search of a clear presentation of rules and formulas. This search was a determining factor in many teachers' preference for Set B over Set A.

After these two large reviews, we examined each of the 23 papers more carefully to confirm the tentative themes developed during initial reviews. In all, each individual paper was reviewed at least four times to develop major themes. All quotes pertaining to a particular theme were compiled electronically and were selected for inclusion in this report on the basis of how clearly they expressed the theme and how representative of the theme they were.

Preservice Teachers' Analysis of the Instructional Materials

In this section, we present themes that were most common to the teachers' papers, followed by a short discussion of less common but very noteworthy themes from a few teachers' papers.

In Search of Familiar (Traditional) Components

Eleven of the 23 preservice teachers specifically cited their own past experiences with traditional mathematics textbooks and lessons as major influences on their interpretations of the two sets of instructional materials. Consider, for example, Erin's comment about Set B: "[Set B] is done in a much more structured fashion than Set A. The way that this lesson plan is structured is more of what I am used to, and what I feel is effective when teaching math to children." Because Erin was more familiar with the traditional form of Set B, she seemed to be more convinced of its effectiveness in the classroom. Allison expressed similar ideas as she discussed Set B. "From a teacher's point of view, I would prefer to use Set B. . . . [This is] the type of lesson that I grew up on as a child, and maybe that is why I am partial to this particular lesson." Allison too emphasized a sense of comfort based on familiar experiences and exposure to more traditional instructional materials.

Most of the preservice teachers (20 out of 23) not only preferred Set B due to its familiarity, but also disliked Set A due to its lack of familiarity. Because they searched each set of instructional materials for familiar traditional features (e.g., rules, examples, practice problems), the teachers tended to comment most about what *was not* in Set A and what *was* in Set B (and less about what *was* in Set A and *was not* in Set B). The following statement made by Sophia illustrates this theme: "Set A

did not provide examples or formulas, which I think is a bad idea. It is not necessary in this lesson to have them, but it is still a good idea." Sophia communicates, as do many of the preservice teachers, that example problems and formulas of the type appearing in Set B should have been included in Set A. Although Sophia suggested that formulas and examples are not needed in Set A, she still expressed a desire to include these elements somewhere in the materials.

Of the 16 teachers who did articulate the goal of Set A, 13 teachers noted its failure to include more traditional mathematical and pedagogical features. Consider Amy's description:

> In Set A they are trying to get the child to come up with their own way of finding area. They don't want to just come out and tell them what the formula is like in Set B. I think it is good for the children to initially investigate and see if they can come up with ways to find area on their own, but I think after some investigation, they should be given the formulas for reference and clarity.

Like Sophia, Amy suggests that formulas should be listed somewhere within Set A. Although she sees some benefits of Set A's design, Amy maintains a desire for instructional materials to present formulas to students.

In general, and perhaps not surprisingly, the preservice teachers' interpretations of the instructional materials reflect the prominent view that students need to be *told* the mathematics they are expected to learn. For instance, it was common for teachers to comment on the value of Set B's clear presentation of important ideas. Consider, the following statement made by Allison when discussing Set B:

> The objectives, terms, and formulas were displayed in boxes so that they were set apart from the rest of the lesson. I think that this is a great idea because then students can look back and review the major concepts briefly if needed. . . . Overall, I prefer Set B because it reinforces the main concepts through clear bulleted format.

The organization and "bulleted format" of Set B were actually cited by Allison as her primary reasons for preferring Set B to Set A. Although not stated, it is quite possible that Allison (and the other preservice teachers who mentioned organization as a key factor in their like or dislike of a particular set of instructional materials) is most concerned with what the boxed and bulleted organization represents throughout the materials: a direct presentation of the concepts, formulas, and ideas needed to complete the task at hand. She seems to be associating the overall mathematical goal of this set of materials with the direct, immediate presentation of information—a hallmark of traditional mathematics instruction.

Using Traditional Expectations to Make Questionable Interpretations of the Instructional Materials

The influence of preservice teachers' familiarity with more traditional instructional material components was, at times, so strong that it led them to inaccurately describe the two sets of instructional materials or to arrive at questionable conclusions about the materials. Certainly instructional materials can be interpreted in many ways. However, 14 teachers' traditional assumptions about what a set of instructional materials should contain actually resulted in descriptions that neglected or misrepresented critical features of each set.

For example, when invited to describe her favorite component of each set of instructional materials, Erin wrote:

> In Set A, I liked how it clearly explains all of the information. . . . My favorite component of Set A is how thorough the lesson plan is. It is lengthy and provides many opportunities for practicing the concepts. This can make unclear students more clear on concepts and lets them learn through repetition, which can be very effective.

Erin describes Set A as providing a clear explanation of the information followed by

opportunities for practicing the concepts. Actually, Set A offers very little explanation, instead providing questions that help students to develop a formula for finding area. Considering their guiding nature and placement within the materials, it would seem difficult to categorize these questions as practice (as Erin does). The goal of Set A is not to illustrate a process or procedure and have students practice,[2] but to provide an opportunity for the gradual development of the concept through student exploration.

For another example of this theme, consider the following statement made by Allison, as she attempts to describe a problem from Set A:

> Throughout [Set A], there are several characteristics that would help a student better grasp the concept. For example, there are a number of problems that the students are instructed to solve using the formula. Problem 5.1 offers a variety of shapes so that the student learns how to apply the formula to more than one situation.

This description is also rather inaccurate. The problem to which Allison refers does ask students to find the area of several parallelograms; however, it does not ask them to use "the formula" to solve the problems. It instead includes a square grid background and asks students to explain how they found the area of each shape, leaving open the possibility of students developing different methods and ideas about how to find area.

It is possible that these inaccurate descriptions of Set A arose out of a lack of close reading and effort on the part of our preservice teachers. However, both Erin and Allison seemed to have a fairly good understanding of the ultimate goal of Set A. For example, in another part of her paper, Allison states the following about Set A:

> Students are asked to explore the notion [of area] themselves, conclude from their findings, and then explain them. . . . This will only benefit the student's understanding of area and will divert him/her from simply memorizing facts and formulas.

Given this description, it seems fair to conclude that Allison, and perhaps many of her classmates, made some quick judgments about problems or activities in Set A based on what she thought *should have been* included in the materials. The use of words such as "explanation" and "practice problems" as highlighted by Allison and Erin are certainly terms and processes with which they are comfortable. However, these terms are simply not accurate descriptors of Set A.

In Search of Nontraditional Components: More Questionable Analysis

A substantial number of the preservice teachers (15 out of 23) expressed an interest in instructional materials containing cooperative group work, an important component of reform-oriented mathematics instruction. Interestingly, the teachers tended to assume that problems or activities outlined in the two sets of instructional materials would be completed by students individually, unless explicitly indicated in the materials as "group work." Consider a statement made by Erin when discussing Set A:

> Many students need the opportunity to interact with other students to gain a better understanding of the presented concepts. Much of this "individual work" could present a problem for students who are not these types of learners.

Although Set A never specifically indicates group work anywhere within its pages, it also never indicates that the problems are to be completed individually. In fact, successful completion of the open-ended problems of this set of instructional materials would demand extensive student interaction and exploration. However, Erin's statement seems to indicate an automatic default to assuming individual student work when analyzing Set A.

Elizabeth's writing about group work is illustrative of the same assumptions made by Erin (above) and of the theme, discussed previously, of teachers' focus on what is *not* in Set

A. Consider Elizabeth's overall descriptions of the two sets of instructional materials:

> Set B was able to offer the students group work, hands-on activities, show how it is relevant in people's lives, wrote a clear objective at the top of the paper and the directions were much easier to understand. Set A did not offer group work, a hands-on activity, a clear objective, show how it is relevant, nor did it have directions that were as easy to follow as Set B.

It may be the case that Elizabeth's and other teachers' comments are reactions to two problems (out of 24) in Set B that indicate potential interaction among students. The question, "How many square inches are in a square foot" (Gardella et al., 1992, p. 447) is labeled "Discussion" and a problem incorporating newspaper advertisements to compare the cost of various types of flooring (p. 449) is labeled "Group Activity." Although it is certainly not our intent to discredit the importance and quality of these two problems, it is important to point out here that these indicated interactive problems make up only a small portion of Set B. It is interesting that Elizabeth, in addition to many other preservice teachers, characterized Set B as being more interactive and group oriented than Set A. As teachers' descriptions illustrate, assumptions about student interaction were based entirely upon indications of such within each set of instructional materials.

Justifying Differences Between the Two Sets of Instructional Materials

Although they were not asked to do so, 14 of the 23 teachers were compelled to discuss why such different sets of instructional materials might exist. In one way or another, most of these preservice teachers communicated a belief that each set of materials had been created for a different type or level of learner. Consider the following statement made by Elizabeth:

> Maybe Set B is targeted to a younger audience and that is why the directions and explanations are much easier to read and understand. Set A could be targeted for an older audience that should already know the material and might not need the explanation to go along with it.

This statement gives us insight into Elizabeth's beliefs about the learning of mathematics. She argues that Set A would only be used with students who have already learned the concepts and formulas associated with area. Elizabeth appears to be either unaware of the purpose of the exploratory nature of Set A or does not believe in its ability to lead students to their own understanding and development of the concepts.

Similar to Elizabeth's reasoning, Helen made the following observation about the two sets of instructional materials and their intended usage by students:

> It seems [Set A] would be best used with a group of students who has a hard time with math, or that is below or on grade level in their math work. This does not mean it is not a good lesson, because it is; however, a group of above grade level math students would not find this lesson very challenging. . . . Set A never gives the child the formula for finding the area of any of the shapes used. This bothers me because I believe at some point it is necessary for even the slower math students to have the formula to use with the practice problems.

Helen indicates that Set A was created for students who have "a hard time with math." Although this statement could be interpreted in many ways, Helen's later comment about the problem she has with Set A never providing a formula ("it is necessary for even the slower math students to have the formula") indicates her belief that formulas are the ultimate learning goal to be achieved by students when going through a mathematics lesson. Her critique of Set A does not include an analysis of the kind or quality of problem within the materials; it instead focuses on the exclusion of an explicitly defined formula. Brenda, as do most of the preservice teachers, agrees when she comments: "Set A is more simplified than Set B. Set B takes it to a higher

degree using more complicated formulas and word problems."

A few of the preservice teachers were able to identify the different mathematical goals and implied assumptions about mathematics learning within each set of instructional materials. They tended, however, to identify these differences only when describing the students for whom they believed these sets of materials were intended. Take for example a comment made by Shelly when discussing the differences between the two sets of materials:

> I think both sets do a good job of getting the ideas across but for different types of learners. For Set A, people that like to see the problems done visually and learn better by figuring it out themselves will learn better from this lesson. Set B is for students that learn best from memorizing formulas and plugging numbers in to find out the answer.

Mary communicates a similar, albeit more critical, sentiment to Shelly's comment when she states: "Sure this lesson [Set A] may be great for the inventor kids, but not for those already struggling with math and the concept of area."

These comments about the instructional materials and the students for whom they were written provide insight into several notions of mathematics teaching and learning communicated by the preservice teachers. First, and probably most obvious from these statements, is the general belief that those students who would be labeled as slow learners of mathematics by these preservice teachers learn mathematics in different ways than do students who excel in mathematics. Coupled with this idea is the notion that these slower learners work through simple problems without the use of formulas—the formulas are saved for more advanced learners of mathematics.

Less Common Analysis Among a Few Preservice Teachers

Comments made by three of the preservice teachers, although not typical of the larger group of teachers, offer some important themes that are worthy of consideration. These themes suggest possible ways that instructional materials analysis may offer some teachers, who are perhaps at a different place in their development as teachers, opportunities to articulate their conceptions.

Consider, for example, the comments made by Margaret as she discusses Set A:

> I like the fact that Set A gives more of an open-ended opportunity for children to learn rather than Set B, with "right" or "wrong" answers. . . . Set A is better because it involves the students and lets the students come to a mathematical idea without memorizing rules and formulas. I feel as if the students would actually LEARN the concept of area in a parallelogram and triangle rather then memorize a formula. . . . Overall, I like Set A much better. If given the option to choose, I would use Set A in my classroom. I would feel as if the material and mathematical concepts would actually stick with children in the long run, whereas a formula might be forgotten in a week.

Margaret indicates that Set A allows students to explore ideas on their own and come to their own mathematical understandings without having to memorize a formula. Margaret has identified why a formula might not be included in Set A and appears to appreciate the potential benefits of that approach.

Similarly, Jean comments on the role of exploration in students' growing understanding of concepts and procedures:

> This lesson requires students to explore topics on their own, coming to conclusions about the concepts using what they know and what they learn from experimenting with the problems given in the lesson. . . . Having the students explore the topics on their own makes sure that they have a true understanding of the material and why the formulas work the way that they do.

Jean also relates her own past learning experiences to Set B.

> I remember completing lessons similar to Set B and never learning the information. I would skim through the beginning explanation and then complete the problems, giving little attention to what was actually stated in the reading. I think that Set A would give the students a better thorough understanding of the material.

Although Jean is familiar with instructional materials like Set B, she indicates a belief that Set A would offer students a chance to develop more thorough understandings.

Finally, consider comments made by Teresa when discussing which set of instructional materials is better for students:

> Set A is better for the students. It allows them to explore the concepts themselves so they learn how to find the measurements themselves. By exploring different ways to solve the problems, it gives solutions for many students to understand. They gain a better understanding as to why the solutions work and how they work, so that it will be easier for them to solve the problems and to remember how to do so.

Clearly Teresa has made a connection between the way students engage with mathematics and the resulting nature of their knowledge.

Each of these three teachers points out the importance of the exploratory approach of Set A and how this exploration may allow students to develop deeper, more meaningful, and lasting understandings. They also identify the value of letting students develop their own solution methods and assert the importance of this in relation to students understanding why and how solution methods work and make sense. Although these opinions were certainly not in the majority, they highlight very important ideas that can arise as preservice teachers examine instructional materials.

Discussion and Implications

This instructional materials analysis assignment had two primary purposes: (1) to inform us, as researchers and teacher educators, about preservice teachers' conceptions of instructional materials, and (2) to determine if an analysis assignment might be a useful teacher education activity in a mathematics course early in teachers' programs of study. In this section, we revisit those purposes in light of the results of the teachers' analyses.

The results of our instructional materials analysis assignment are consistent with the widely accepted notion that preservice teachers' prior schooling experiences have profound effects on their conceptions of teaching and learning (Ball, 1990; Lortie, 1975). It is not surprising that when our preservice teachers attempted to analyze different sets of instructional materials, their prior experiences in traditional classrooms, or the "apprenticeship of observation" (Lortie, 1975, p. 61), played a considerable role.

We were, however, somewhat surprised by the *strength* of the traditional element of the teachers' conceptions of appropriate instructional materials. Many teachers not only conducted their analyses from the perspective of past experiences with traditional instruction, but they actually applied their expectations so heavily that they sometimes made faulty interpretations of the instructional materials. This result is particularly interesting in light of the fact that the teachers were using curriculum materials similar to Set A for their own mathematical learning in the course.

Although many teachers used traditional criteria to evaluate the instructional materials and gave little or no credit to more innovative instructional approaches, we remain optimistic about the role of instructional materials analysis in preservice teacher education. In fact, the traditional nature of teachers' conceptions suggests that teachers may benefit from *more* instructional materials analysis. Through this activity, teachers were invited to carefully reflect on and articulate their ideas about what constitutes effective instructional materials. For our students, this activity may have been their first experience viewing instructional materials from the perspective of a teacher.

We also recognize that there are many ways that this assignment (and perhaps the course activities surrounding it) might be improved. Based on the results of our attempt at engaging students in the analysis of instructional materials, we propose that improvement be aimed, at least initially, at the following three areas:

- increasing teachers' focus on the depth and type of mathematical understandings that students might gain from different instructional materials,
- improving teachers' analysis of the purpose or quality of student interaction and cooperation in the classroom, and
- developing teachers' sense of themselves as curricular decision makers.

Suggestions for how we might make such improvements are elaborated below.

The preservice teachers in our course seemed to be more concerned with the clarity of the presentation of information in the instructional materials than with a deeper consideration of the kinds of understandings students might develop through engagement with these particular sets of materials. Teachers seem to have some primitive notions about learning styles, as evidenced by their comments about how certain learners might be more successful with a more (or less) open-ended set of instructional materials. These notions may offer an excellent starting point for teachers to more critically consider their assumptions about learners and learning. Our assignment (see Appendix) may improve with the addition of one or more questions that draw teachers' attention to the specific mathematical understandings that students would gain from Sets A and B. It may also be the case that teachers would benefit from more extensive reflection on their own specific mathematical understandings before attempting to compare instructional materials. For example, our teachers actually used Set A later in the semester for their own mathematical learning about area. Reversing the order of these assignments could promote the development of deeper mathematical understandings among the preservice teachers. Greater familiarity with Set A might increase teachers' ability to consider its pedagogical merits. It may also be the case that teachers' pedagogical content knowledge would be enhanced as a result of this explicit connection between content and pedagogy (Ball & Bass, 2000).

Teachers' written analyses of the two sets of instructional materials contained little attention to the quality or purpose of student interaction. None of the preservice teachers taking part in this analysis attempted (in writing) to explore which types of problems would be effective for group work or discussion. It is important for teachers to recognize that how mathematics is taught is intimately connected to how it is learned (Carpenter, Fennema, Franke, Levi, & Empson, 1999; Hiebert et al., 1997). Although some teachers indicated an interest in cooperative learning, the teachers did not appear to take classroom communication as a serious criterion in their evaluations. As suggested above, this problem may be addressed by the addition of pointed questions to our assignment. It may also be aided by more extensive discussions in class about the different teaching and learning theories that underlie instructional materials.

Many preservice teachers attend teacher education courses with the desire to be told how to teach. The teachers in our course appear to have carried the same perspective into their analysis of the instructional materials. As the example above illustrates, the teachers seemed to view the instructional materials "as is"—they seemed reluctant to make assumptions about and possible modifications to the materials. Teachers will need to learn to view curriculum as adaptable if they are to adopt what Ball (1993) describes as a "bifocal perspective—perceiving the mathematics through the mind of the learner while perceiving the mind of the learner through the mathematics" (p. 159). Attending to students' developing mathematical ideas and the mathematics that students are to learn, the teacher must be poised to make difficult but necessary decisions about what happens in the classroom.

How can we alter our instructional materials analysis assignment to better prepare teachers to play key roles in curricular decision making? Although teachers were asked about making changes to the instructional materials (Question 7 of the assignment—see Appendix), our questions may communicate a somewhat static treatment of the two sets of materials. Our assignment could be altered to *require* teachers to make changes to the instructional materials, for example, by asking them to use the two sets of instructional materials as the basis for two lesson plans (or alternatively one lesson plan which incorporates aspects of both sets of materials). Doing so would require teachers to make choices and decisions about the sets of materials—work they will need to do as teachers.

Teacher educators in other content areas are likely to find that their students' interpretations of instructional materials are similarly influenced by prior experiences in traditional classrooms. We encourage teacher educators in other disciplines to investigate this influence, and moreover to develop and document the effectiveness of course activities that require preservice teachers to critically examine instructional materials. Future research in different content areas may reveal interesting new findings about how preservice teachers' subject-specific experiences impact, and are impacted by, the analysis of instructional materials.

Appendix

Analysis of Instructional Materials

This appendix presents the specific assignment given to the preservice teachers in this project. Teachers received copies of two sets of instructional materials, Set A and Set B, and the following questions:

Part 1—Open-Ended Analysis

For this part of the project, you will carefully read through both sets of instructional materials and type up a separate analysis of each. Your analysis should be as long as necessary to adequately describe and analyze all components of the materials. Before reading through the materials, take the time to brainstorm ideas about what to look for during your analysis.

Part 2—Question-Guided Comparison

1. Upon first glance, what seems to be similar between the two sets of instructional materials? What seems to be different?
2. Look back at the similarities and differences that you listed in Question 1. Why do you think certain components of the instructional materials are different or similar? What is your opinion of the differences and similarities between the materials?
3. What do you like less or more about each set of instructional materials? Why?
4. Which set of instructional materials do you think is "better" for students? Explain your reasoning, making sure to describe what you mean by better.
5. From a teacher's point of view, which set of instructional materials do you like better? Which set of materials do you think would be easier to use in the classroom? Explain.
6. Which set of instructional materials do you think is more commonly used in classrooms? Why?
7. If you could make changes to any part of either of these materials, what would those changes be? Why?
8. What is your favorite component of these two sets of instructional materials? Explain your reasoning.
9. Go through each set of instructional materials again, trying to imagine yourself as a student working through each set. What do you think are the main ideas that you'd get out of each set of materials? How are the main ideas similar and/or different between the two sets?
10. Overall, which set of instructional materials do you like better? If given the option to choose, which set of ma-

terials would you use in your classroom? Why? ATE

Notes

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1. For the remainder of this article, we will use the term *textbook* to refer to traditional mathematics materials and the phrase *curriculum materials* to refer to newer reform-oriented materials. *Instructional materials* will be used to refer to both textbooks and curriculum materials.

2. Although the pages chosen for Set A did not include designated "practice" problems, the *Connected Mathematics* curriculum (from which they were extracted) does contain practice problems at the end of each section of material. Our decision to exclude these practice problems from Set A related to our desire to create a strong conceptual distinction between Set A and Set B.

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